

Bioinvasion Rates

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At least 121 non-native organisms have established themselves in the Estuary's waters and wetlands to date. Such invasions — many of which occur via the discharge of ship ballast water taken up in foreign ports — may constitute the biggest single threat to the Estuary's native biodiversity. More significant than the sheer number of exotics is their dominance in many aquatic communities. In several studies since the 1940s, exotic species accounted for 40-100% of the common species and up to 95% of the biomass of several biotic assemblages, including soft-bottom benthic organisms, dock- and hull-fouling organisms, zooplankton in the northern part of the Estuary and fish in the Delta. Moreover, the rate of invasions has been increasing: Between 1850 and 1970, an average of one new species became established in the Estuary every 46 weeks; since 1970, the rate has jumped to one new species every 15 weeks. Some of these invasions have greatly altered habitat structure and the flows of nutrients and contaminants, and, through predation, competition and the introduction of parasites, have contributed to reductions and extinction's of native species. The economic costs of exotic species include damaged marine facilities, weed-choked waterways, fouled water intakes and undermined river and ditch banks.

Fish Invasions

Since Gold Rush times, 18 fish species have successfully invaded the Estuary, and more invasions seem inevitable. These introduced fish species occur mainly in fresh and brackish water, where they often dominate in terms of numbers and/or biomass. A certain amount of integration has taken place among the native and introduced species, resulting in new assemblages that seem to respond in concert to estuarine conditions. Invading species have also likely contributed to the decline of native species, not to mention increasing uncertainty about the effectiveness of management measures designed to enhance populations of declining native species (because it is hard to separate the effects of a new invasion from changes to the environment). Inland silversides, for example, may be

partially responsible for the Delta smelt decline because they prey on smelt eggs and larvae, while wakasagi may make smelt recovery more difficult because this invader hybridizes with and may compete with the smelt. Some invaders, such as the shimofuri goby, appear to have had no major effects on the native biota but could invade estuaries elsewhere via the California aqueduct and then compete with and prey on the endangered tidewater goby. Two fishes likely to invade the Estuary in the near future are the northern pike and white bass (established due to illegal introductions for sport fishing). As top predators, they are more likely to cause significant ecological change and greatly alter current fish communities. With today's increased knowledge of introduction pathways, all future invasions must be regarded as preventable and therefore the responsibility of those making the introduction.

Mitten Crab

The invading Chinese mitten crab (*Eriocheir sinensis*)— responsible for millions of dollars in damage in Europe — was first collected in South San Francisco Bay in 1992 and has since steadily increased in abundance and distribution. Crabs were collected in San Pablo Bay in the fall of 1994, Suisun Marsh in February 1996 and the Delta in August 1996. Its distribution in South Bay creeks also continued to expand in 1996, with mitten crabs reported approximately 30 miles upstream from the mouth of Coyote Creek and in the Niles Canyon section of Alameda Creek. In the South Bay, mitten crab burrows are common in tidally influenced areas with steep banks that are high in clay content and lined with vegetation. Burrow densities as high as 30 per square meter have been reported from South Bay sloughs. In other areas, mitten crab burrowing has accelerated bank erosion rates and slumping. As their population grows in the Delta and other parts of the Estuary watershed, the crab's burrowing activity could pose a serious threat to the structural integrity of the levees.

Excerpted from *State of the Estuary , 1992—1997* (San Francisco Estuary Project: 1997), p. 20-21.

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Nautilus Institute

2342 Shattuck Ave. #300, Berkeley, CA 94704 | Phone: (510) 423-0372 | Email:

nautilus@nautilus.org